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SCIENCE NEWS LETTER

AUG 1 1932

THE WEEKLY SUMMARY OF CURRENT SCIENCE •

FULL DETAILS
of SOLAR ECLIPSE
of AUG. 31

JULY 30, 1932

By Hiding, the Sun Reveals Itself

See Page 63

A SCIENCE SERVICE PUBLICATION

SCIENCE NEWS LETTER

VOL. XXII *No 590*

The Weekly Summary of Current Science

Published by

SCIENCE SERVICE

The Institution for the Popularization of Science organized under the auspices of the National Academy of Sciences, the National Research Council and the American Association for the Advancement of Science.

Edited by WATSON DAVIS

Subscription rates—$5.00 a year postpaid; two years, $7.00; 15 cents a copy. Ten or more copies to same address, 5 cents a copy. Back numbers more than six months old, 25 cents.

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Publication Office, 1930 Clifton Ave., Baltimore, Md. Editorial and Executive Office, Constitution Ave. at 21st St., N. W., Washington, D. C.

Address all communications to Washington, D. C. Cable address: Scienserve, Washington.

Entered as second class matter October 1, 1926, at the post-office at Baltimore, Md., under the act of March 3, 1879. Established in mimeographed form March 13, 1922. Title registered as trade mark, U. S. and Canadian Patent Offices.

THE SUN WILL GO OUT

THE MOON will slowly blot out the sun. The rush of a gigantic shadow across the earth will turn day into night. The sun's corona halo will flash suddenly. Stars will shine in the daytime. The air will have a sudden chill. The greatest astronomical show on earth is scheduled for Wednesday afternoon, Aug. 31, when there will be an eclipse of the sun. The best seats can be found along a hundred-mile-wide band passing through Canada and New England. The public by the thousands and astronomers by the score will occupy vantage points within the path of total eclipse.

Astronomers welcome the opportunity of studying the outer part of the sun for a fleeting maximum time of a hundred seconds. They are now spending days of preparation. The corona can be seen only during the time of total eclipse. It may hold secrets that will affect man's understanding of weather, sun's energy, and radio.

In observatories here and abroad, cameras, spectroscopes, and other apparatus are being groomed for the coming eclipse. Science Service has surveyed the preparations and finds that over 20 parties of astronomers totalling over 200 scientists will be located at some 15 places within the band of totality when the eclipse occurs.

Partial Eclipse Information

Add a. m. to figures before 12:00 and p. m. to figures after 12:00. Correct the standard time given if on daylight saving time. The extent of the eclipse in per cent. is the amount of the sun's diameter that is darkened at maximum eclipse.

At	*Start*	*Middle*	*End*	*Standard Time*	*Extent*
Albany, N. Y.	2:19	3:30	4:35	Eastern	97%
Pittsburgh, Pa.	2:18	3:30	4:38	Eastern	88%
Atlanta, Ga.	2:28	3:40	4:46	Eastern	73%
San Francisco, Calif.	10:56	11:41	12:26	Pacific	15%
Buffalo, N. Y.	2:14	3:26	4:33	Eastern	91%
Boston, Mass.	2:23	3:32	4:36	Eastern	99%
Cincinnati, Ohio	1:16	2:29	3:36	Central	80%
Cleveland, Ohio	1:14	2:27	3:34	Central	87%
Denver, Colo.	11:56	1:05	2:11	Mountain	49%
Chicago, Ill.	1:07	2:20	3:29	Central	79%
Kansas City, Mo.	1:06	2:19	3:27	Central	65%
Minneapolis, Minn	12:55	2:09	3:18	Central	75%
Los Angeles, Calif.	11:11	11:56	12:40	Pacific	15%
New Orleans, La.	1:32	2:43	3:48	Central	59%
New York, N. Y.	2:23	3:34	4:39	Eastern	95%
Philadelphia, Pa.	2:23	3:34	4:40	Eastern	93%
Portland, Ore.	10:30	11:29	12:28	Pacific	33%
Raleigh, N. C.	2:29	3:40	4:46	Eastern	84%
Salt Lake City, Utah	11:49	12:53	1:56	Mountain	39%
Seattle, Wash.	10:25	11:27	12:28	Pacific	38%
St. Louis, Mo.	1:11	2:25	3:33	Central	71%
Tallahassee, Fla.	2:36	3:47	4:52	Eastern	68%
Washington, D. C.	2:24	3:35	4:41	Eastern	89%

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Layman Takes Great Interest In Viewing Total Eclipse

Millions are Expected to Watch the Sun When Darkened By Moon for Brief One-and-a-Half-Minute Interval

WHEN, on the afternoon of Wednesday, August 31, the shadow of the moon sweeps across eastern Canada and New England at the rate of some two thousand miles an hour, hiding the sun for a little over a minute and a half, probably millions of people will see this most magnificent of natural spectacles, a total eclipse of the sun. In an earlier day, the event would have struck terror into the hearts of those who observed it. But now, thanks to the wide dissemination of scientific knowledge, laymen know its cause just as well as they know why the sun rises in the east in the morning, and sets in the west in the evening. They can appreciate the grandeur of the eclipse without fear of its consequences.

Beautiful and impressive as the total eclipse is to the layman, it has far more importance to the astronomer. Observable eclipses are rare occurrences, and one in a conveniently accessible part of the world, at a favorable time of day and with good chances for clear weather, is the chance of a lifetime. Only at the time of a total eclipse can the sun's outer layer—the corona[1]—be observed. So rare are total eclipses, and so short are they at best, that in the last half century, since the introduction of photography began the modern study of the sun, the corona has been observed for less than an hour.

Only Opportunity

Other important observations of the spectrum of the sun's atmosphere, of the stars and planets close to the sun, of the radio effects of the sudden passage of the moon's shadow, of the curious fleeting shadow bands, which may appear on the earth's surface before and afterwards—these and many others can be made either only at an eclipse, or else better then than at other times.

[1]FRONT COVER ILLUSTRATION

The pearly corona of the sun, visible only during total eclipse, is expected to appear as pictured on the front cover during the coming eclipse. This photograph was taken by the Yerkes Observatory expedition during the 1900 eclipse. Then as now there were few spots on the sun and the streamers at the poles of the sun were short and bushy instead of long as they are at time of sunspot maximum.

The three actors in the pageant of August 31 are the sun, 864,000 miles in diameter; the earth, 7,918 miles in diameter, and 92,900,000 miles from the sun; and the moon, 2,160 miles in diameter, 238,857 miles from the earth, on the average. Of these three bodies, only the sun shines with its own light. The other two are illuminated by it. Both cast shadows into space behind them. Because the orbit of the moon around the earth is inclined to that in which the earth revolves around the sun, it is only occasionally that the shadow of one of the dark bodies falls upon the other. At every full moon, the three bodies are almost in line, with the earth in the middle. Similarly, at every new moon, they are almost in line again, but with the moon in the middle. Because they are not quite in line, the shadow of one body usually passes to the north or to the south of the other.

Eclipse of Moon

However, at least twice in a single calendar year, and five times in some years, the moon is at the node, the point where its orbit crosses that of the earth, at the time that it is new. Then the shadow touches the earth, and the sun can be seen eclipsed from some part of our globe. When full moon occurs when three bodies are in line, there is an eclipse of the moon, but these are less frequent than those of the sun. There can never be more than three eclipses of the moon in a year, and a year may pass without one. But when the moon is eclipsed, it can be seen from about half the earth. A total eclipse of the sun, however, can only be viewed from the narrow path of totality, seldom more than a hundred miles wide or a few thousand miles long. On the average, a total eclipse of the sun can be seen from a particular point only once in about 360 years.

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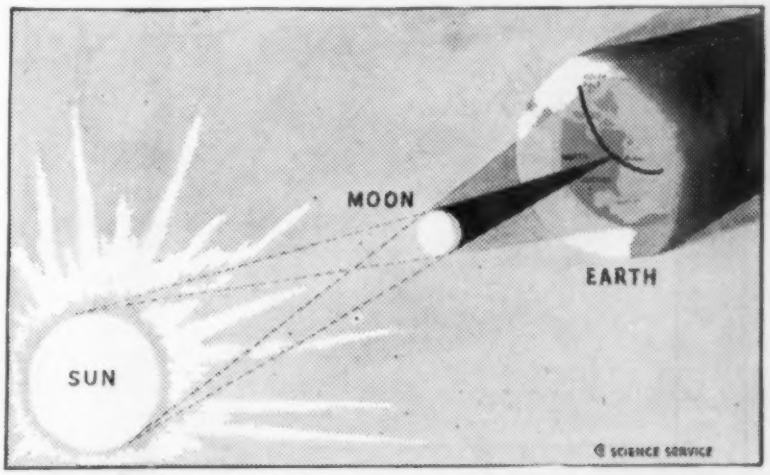
Earth is Only Planet Where Eclipse is Visible

IF THE SUN were a little larger, or a little nearer the earth; or if the moon were a trifle smaller, or farther away, a total eclipse of the sun, like that to be viewed in Eastern Canada and New England, would be impossible. The earth is particularly favored, because from none of the other planets are the conditions right to make a total eclipse.

When you look at the sun in the sky, it seems to have the same diameter as that of the moon, about half a degree in angular measure. This is approximately the size that your little finger nail appears at arm's length. Yet the moon is far larger than the finger nail, and the sun is much bigger than the moon. The three objects appear to be the (*Turn Page*)



HOW THE MOON WILL ECLIPSE THE SUN

The sun is 864,000 miles in diameter and is 92,900,000 miles from the earth. The moon is 2,160 miles in diameter and 238,857 miles from the earth on the average. Only the fortunate spacing of the sun, moon and earth in space allows the phenomenon of a total solar eclipse.

same size because they are at different distances.

Sun Just Covered

For this reason, when the moon comes between earth and sun, it just covers the bright solar disc. The intense glare from that part eliminated, the outer envelope, the corona, which is only about a millionth as bright, comes clearly into view. But the relative distances of the earth, sun and moon change little, and an eclipse may occur when the moon is farther from the earth than the average. Then, the moon seems a bit smaller than the sun, and though it comes directly in front, a ring of sunlight remains visible around its dark disc. This is called an annular eclipse, and is not so important scientifically, because even the small remaining part of the sun's disc is bright enough to blot out the corona. Were the moon a little smaller than it is, all solar eclipses would be annular, and we would never know that such a thing as the corona encircles the sun.

Something like this would take place on Mars. Though that famous planet has two satellites, they are both extremely small. Phobos, the larger, is probably not more than 10 miles in diameter, while Deimos, which is the outer one, is believed to be about 5 miles in diameter. Phobos is about 3,720 miles from the Martian surface, so that even under best conditions, its diameter in the sky would be only about a third that of the full moon as seen from the earth, and every solar eclipse there would be annular. Deimos, in addition to being smaller, is much farther away, and would appear merely as a bright planet, something as Venus appears to us. When it came between Mars and the sun, it would appear only as a small black spot on the solar disc.

Eclipses on Other Planets

Since Venus and Mercury have no satellites, they could have no eclipses. Jupiter and Saturn are well provided with them, but they are so far from the sun that it would appear much smaller than from the earth, and the features of a total eclipse from the earth could hardly be observed. The same thing is true, to an even greater extent, for Uranus, Neptune, and Pluto, if that body has any satellites. From these distant planets, the sun would look like a very bright star.

Those who see the magnificent sight of the total eclipse on August 31 will agree that we are fortunate in living on a planet where such an event can occur.

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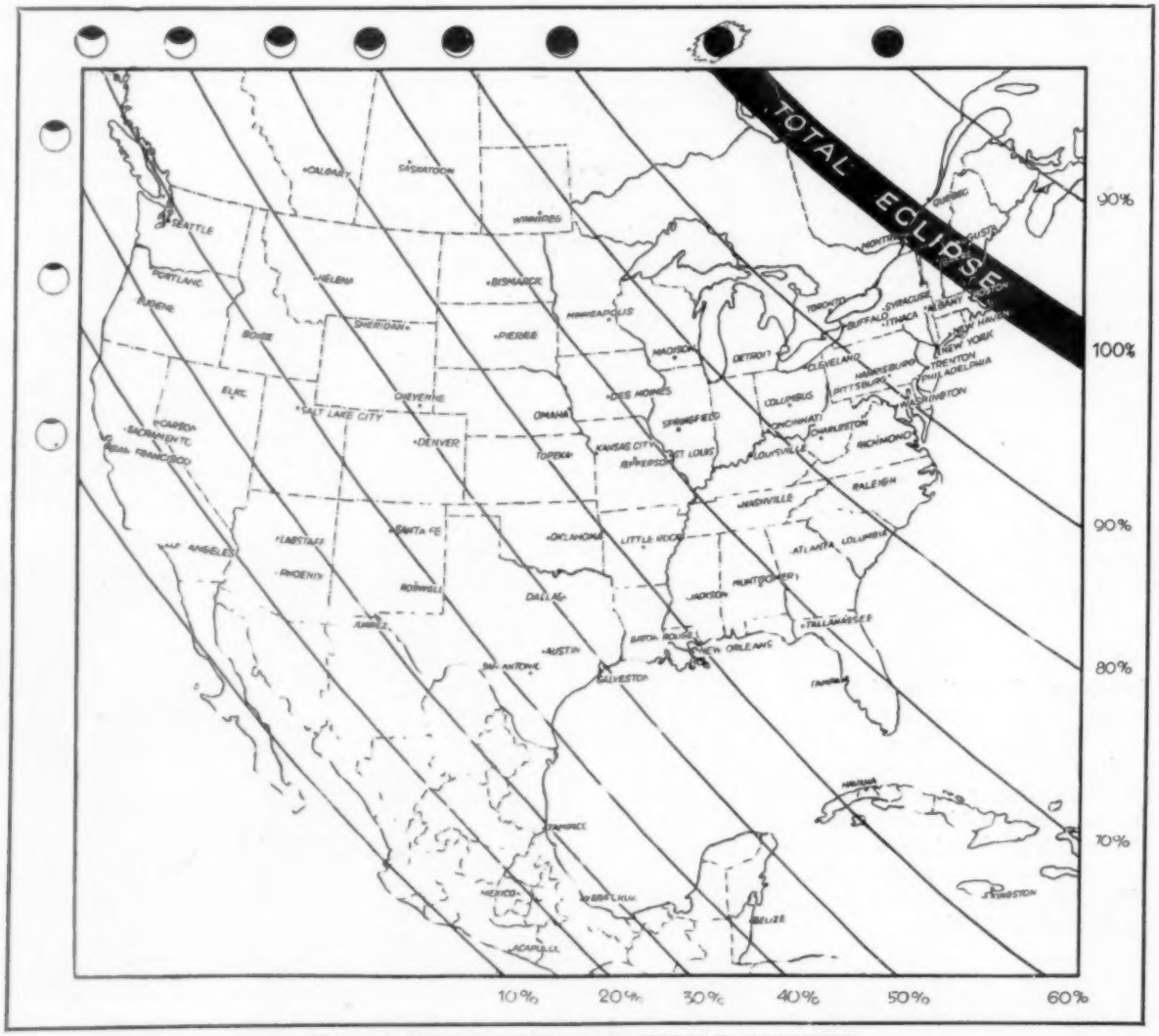
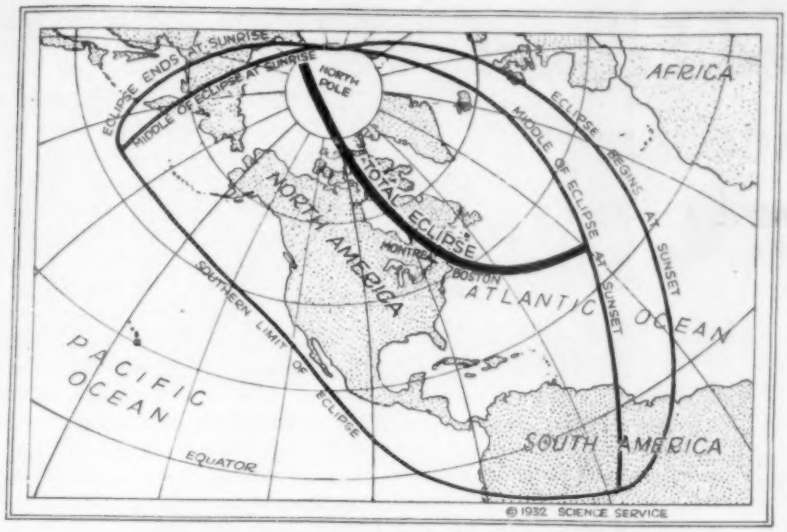


SUN'S ECLIPSE VISIBLE FROM WHOLE COUNTRY

In its partial phases the eclipse of the sun on August 31 will be visible in all parts of the country. This map shows how much of the sun will be obscured at various localities. The band of total eclipse is also shown. Since the path of totality passes near the great centers of population, the phenomenon will present a very striking appearance to most of the people in the United States.



WHERE MOON'S SHADOW STRIKES EARTH

The black line is the narrow path of total solar eclipse. The area of the earth from which the partial phases of this phenomenon are visible is also shown on this map.

Paths of Totality Crosses Popular Vacation Section

Hundred-Mile-Wide Shadow Hits Earth First Among Eskimos But Later Traverses Quebec and Cape Cod Region

MILLIONS of people are expected to view the total eclipse of the sun visible in Eastern Canada and New England. Probably never before, with the possible exception of the eclipse seen in New York, Pennsylvania and the New England states on January 24, 1925, has the attention of so many been concentrated on such a celestial event. Not only is the hundred-mile path over which the eclipse will be seen a well settled region, but it is also a popular vacation resort. The regular population will be greatly augmented by the large number of summer tourists, many of whom are regular visitors, while others are especially attracted by the eclipse.

Begins in Arctic Ocean

The greater part of the eclipse path, however, is over uninhabited territory. The shadow of the moon will first touch earth in the Arctic Ocean, north of Taimir Peninsula, in Northern Siberia, at sunrise, which will be at 2:04 p. m., Eastern Standard Time. Then it will travel northward, passing within a few hundred miles of the North Pole. Starting south, it will traverse more of the Arctic Ocean, northern Canada, Hudson Bay and James Bay. So far, it will have passed over few human beings, including perhaps some Eskimos, an occasional explorer and some trappers. But then it enters the province of Quebec, and begins to reach civilization. A little town named Parent, on the Canadian National Railway is in the path. Then it comes down to the St. Lawrence River, covering that river from Montreal to a point east of Three Rivers, but not as far as the city of Quebec. In southern Quebec it crosses Lake Memphremagog, including the town of Magog.

Entering the United States, it passes over northwestern Vermont, Montpelier being right on the southern edge of the path. It covers all of New Hampshire, except the southwestern corner. Southern Maine, and northeastern Massachusetts are included with such points along the coast as Salem and Gloucester, Mass., Portsmouth, N. H., York Harbor, Kennebunkport, Biddeford, Portland, Boothbay and Newagen, Maine. After crossing Massachusetts Bay, the edge of the shadow crosses Cape Cod, including Provincetown. Chatham is the last bit of land that it touches. Then the shadow passes out to sea, and ends in mid-Atlantic, at a point in longitude 41 degrees west and latitude 28 degrees north, at sunset, which comes there at 4:03 p. m., Eastern Standard Time. Thus, less than two hours will have been required for the 6,000-mile trip.

Red Flames

To a person in the region crossed by the shadow, the dark disc of the moon completely covers the sun's disc, and the sun's outer envelope, the corona, comes into view. Red flames of hydrogen and other gases, shooting out from the sun to heights of hundreds of thousands of miles, may also be seen. The sun obscured, a sudden darkness comes over the earth, for the short period during which the total eclipse lasts. Altogether, it is probably the most impressive of natural phenomena.

Of course, if the sky is cloudy, the eclipse will not be visible from the ground, and every eclipse observer, whether layman, or professional astronomer, has to take a chance with the weather. But records made over recent years for afternoons at the end of August indicate that the chances for clear skies are somewhat better than even, perhaps about 60 per cent., from Quebec south. Even Mt. Washington, which is 6,288 feet high and in the center of the path, has about a 30 per cent. chance of clear weather. And this is better than the chances were on January 24, 1925, when the weather behaved beautifully.

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BOOKS

ECLIPSES OF THE SUN—S. A. Mitchell—*Columbia Univ. Press*, Rev. 1932, $5.

TOTAL ECLIPSE OF THE SUN—Nautical Almanac Office of the U. S. Naval Observatory—*Govt. Print. Off.*, 1931, 35c. (no stamps or checks). Large scale map included.

ASTRONOMY—F. R. Moulton—*Macmillan*, 1931, $3.75.

THE EARTH AND THE STARS—C. G. Abbot—*Van Nostrand*, 1925, $3.

THE SUN—C. G. Abbot—*Appleton*, 1929, $3.

ELEMENTS OF ASTRONOMY—E. A. Fath—*McGraw-Hill*, 1928, $3.

ROMANCE OF THE SUN—Mary Proctor—*Harper*, 1927, $2.50.

ASTRONOMY—H. N. Russell, R. S. Dugan and J. Q. Stewart—*Ginn*, 1926, 2 voumes, $2.48 per volume.

HANDBOOK OF SOLAR ECLIPSES—Mrs. I. E. M. Lewis—*Duffield*, 1924, $1.50.

Ancients Predicted Eclipses With Extreme Accuracy

This Year's Event Foretold in Work Published Half a Century Ago; First Prediction Made in 585 B. C.

AN INVARIABLE source of amazement to the layman is the astronomer's ability to predict eclipses of the sun and the moon years and even centuries in advance. The total solar eclipse which will be seen the last day of August, for example, was predicted with great precision in a work published in Vienna nearly half a century ago. If they desired, astronomers of today could calculate the data for the eclipse that will be seen in the United States on August 12, 2045, set up the instruments with which to observe it, and leave them, confident that their successors in that remote day would have to make only slight adjustments to use them.

But while such great accuracy is a modern achievement, even the ancient astronomers of Greece were able to make a pretty good job of eclipse prediction. At a still earlier date the Chinese were able to make rather rough eclipse predictions. There is a famous story, which may be apochryphal, that one of the Chinese emperors of some 2000 B. C. had two imperial astronomers, named Hi and Ho, whose duty it was to predict eclipses.

Dragon Devoured Sun

They were supposed to be due to a dragon devouring the sun, so if sufficient warning was given, all the natives made horrible noises, to scare the beast, and to cause him to disgorge. But at one eclipse, according to the story, Mr. Hi and Mr. Ho had looked too long on the wine when it was red, and had failed to make the prediction before the sun actually started to disappear. The fireworks, the drums, the gongs and the other noise makers were quickly brought into action, and the eclipse passed safely. But the two astronomers were promptly beheaded for their neglect. It has been said that no astronomer ever since has been drunk at eclipse time.

Thales of Miletus, the father of Greek astronomy, was probably the first man to predict the actual path of an eclipse. This is believed to have been on May 28, 585 B. C., and it happened during a battle between the Lydians and the Medes. They were frightened into a truce, which eventually resulted in peace between them.

Eclipses Repeat

This prediction was possible because of the period called a "saros," in which eclipses repeat. After a lapse of 223 lunar months, or 18 years 11 days, an eclipse will occur again, but about a third of the distance around the earth to the west, and a little farther north, or farther south, depending on the direction the moon is travelling at eclipse time. After three saroses, or 54 years and one month, an eclipse returns to practically the same longitude on the earth, but farther north or south. Probably Thales had heard of an eclipse in April, 639 B. C. not far away, and so predicted its repetition.

Taking the eclipse of August 31, this year, we find that its predecessor was on August 21, 1914, visible in Europe and Asia and crossing the Caspian Sea. Before it was one on August 9, 1896, seen from Japan. This, in turn, was preceded by a very famous one on July 28, 1878, which was seen from the western United States. The great astronomer, Prof. Samuel Pierpont Langley, observed this from Pikes Peak, 14,400 feet high. In the beautifully clear air, he saw the corona extend for 12 solar diameters, more than ten million miles, to one side. Now, as the eclipse is repeated this year, it crosses another mountain peak, Mt. Washington, 6,288 feet, third highest east of the Rockies. Perhaps from this point of vantage more important observations may be made.

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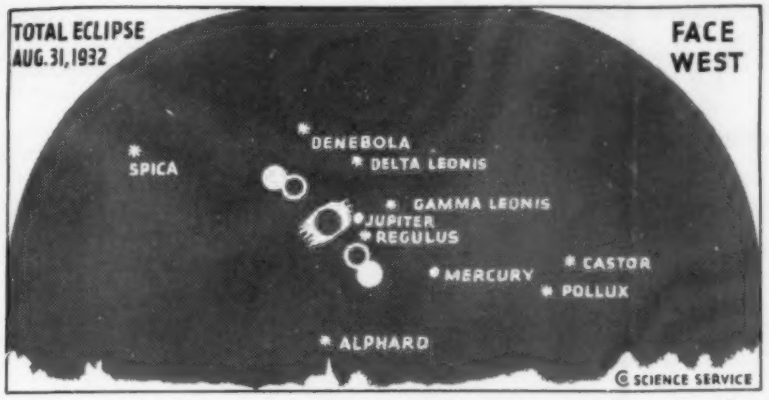
Eclipses of the Past and Future in the United States

Year	Month	Day	Where visible
1778	June	24	Texas to Pennsylvania.
1806	June	16	California to New York.
1834	November	30	Montana to South Carolina.
1869	August	7	North Dakota to North Carolina.
1878	July	29	Montana to Florida.
1900	May	28	Texas to Georgia.
1918	June	8	Washington to Florida.
1923	September	10	Southern California.
1925	January	24	Northeastern states.
1930	April	28	California, Nevada (very brief).
1932	August	31	Canada, New England.
1963	July	20	Vermont, New Hampshire and Maine.
1970	March	7	Florida.
1979	February	26	Washington, Montana.
2017	August	21	California to North Carolina.
2022	April	30	Texas to Pennsylvania.
2045	August	12	California to Florida.



STARS WILL SHINE DURING SEMI-DARKNESS

The obscuring of the sun during the totality of the eclipse will allow stars and planets to be seen. This shows how the western sky will appear. The sun and moon at beginning (upper) and ending (lower) of eclipse are also shown.

Sun's Darkening Makes Visible Sights Seen at No Other Time

Baily's Beads, Corona, Solar Prominences, and Stars Shining in the Day are Part of Rare Spectacle

A TOTAL ECLIPSE of the sun is probably the most impressive spectacle in nature's repertoire. To an observer fortunate enough to be in the path of totality a never-to-be-forgotten celestial drama will be presented.

Anyone who has ever seen an eclipse will recognize that no description can possibly do it justice, but let us try to give some idea of what is in store on the 31st at a point in the center of the path, such as Conway, N. H.; Kennebunkport, Maine; Derby, Vermont; or Sorel, P. Q.

The sun will rise in the morning, and ascend the sky until it reaches the meridian at noon, just as if nothing extraordinary were about to happen. But at about 2:15 p. m., Eastern Standard Time, the sun will begin to take on a strange aspect. No one, of course, should ever look right at the sun with unprotected eyes. To do so is to run the risk of permanent damage to the retina and possible blindness. Smoked glass is an old standby for solar observation, but even better, and more readily available in these modern times, is an old densely exposed and developed photographic negative.

If you have a small telescope, with a tripod, or some other firm support, it may be used. There are special solar eyepieces for telescopes, which reduce the light sufficiently to permit the observer to look right through it when pointed to the sun. Still more convenient, and permitting a view by several people at once, is a white screen, placed where the back of one's head would be when looking through the telescope. A collar, consisting of a cardboard disc with a hole cut in the center, may be placed around the telescope to shield the screen from the direct rays of the sun. Then, if the instrument is pointed to the sun, and it is focussed by pulling the eyepiece in and out, an image of the sun several inches in diameter can be seen on the screen. Perhaps a few sunspots will be visible, though that is not so likely, because this is the time of fewest spots in the eleven-year cycle.

Begins as Nick

With such a device, at about 2:15 p. m., Eastern Standard Time, on eclipse day, a slight nick will appear in the sun's right hand edge, as seen in the sky. This nick will gradually increase in size, finally leaving only a narrow crescent of sunlight. The dark circle, of course, is the moon, invisible until it actually comes in front of the sun. At about 3:30, or about 3:25 in southern Quebec, totality will arrive. If you look to the northwest, you will see the moon's shadow approaching, at a speed of about 2,000 miles an hour. Or, if you look at the sun at this same time, you will see the crescent of sunlight break up into a series of bead-like spots of light. These are called the Baily's beads, after the English astronomer who first described them, and they are caused by the sun's light continuing to shine through valleys on the moon, while adjacent lunar peaks have passed the sun's edge.

But the Baily's beads last only an instant, and there flashes out around the moon's dark disc, now visible in its entirety, the solar corona, which has been observed to extend for nearly 12 million miles from the sun. Now it is safe to look directly at the sun, for the light of the corona is about a millionth as bright as the uneclipsed sun, or about half as bright as the full moon. Possibly you may see some brilliant spots of red light, close to the lunar disc. These are the solar prominences, giant flames of hydrogen and other gases, often rising to a height of several hundred thousand miles. The prominences are the brightest things visible during a total eclipse.

Around the eclipsed sun, which will be in the west, 30 degrees above the horizon, the brighter stars and planets will come into view. The planet Jupiter will shine brilliantly just to the right of the corona; farther to the right, and lower, will be seen Mercury. The star Regulus will appear below Jupiter, Denebola will be above the sun and Spica to the left. Castor and Pollux, the twins, will be visible in the northwest. Though the sun will be obscured, the ground will not be as dark as on a moonlight night. In addition to the light from the corona, there is considerable illumination from the part of the atmosphere outside the conical shadow of the moon.

But not for long can one gaze on the eclipsed sun. At the center of the eclipse path, it will last for about a hundred seconds. Even forty miles either side of the center it will last for at least a minute. But in the outer ten miles of the strip, its duration falls off rapidly. Right on the edge, it may last only a fraction of a second. The end of the eclipse is heralded by the reappearance of the Baily's beads, this time on the right hand edge of the sun. The beads coalesce to form the crescent which increases in size as the moon moves off to the left. At about 4:35 there is again only a nick in the sun's edge, then this vanishes and the eclipse is over.

• Points of View

ST. ALEXIS DES MANTS

THE UNIVERSITY of Toronto party to observe the eclipse will be located at St. Alexis des Mants, Province of Quebec, under the leadership of Prof. C. A. Chant. A forty-foot tower camera with moving plate will photograph the sun and an eleven-foot camera will make long exposure photographs. A special four-lens camera, with two lenses using polarized light, will also be in operation, while motion picture cameras will record time and the shadow bands. The light of the corona will be tested with a 34-inch camera and filters. Members of the party will include R. K. Young, A. Young, J. H. Hornig, and G. A. Cline.

DOUGLAS HILL

TRANSMISSION of radio signals from Douglas Hill, Me., to Cleveland, to study the intensity of reception before, during and after the eclipse will be one of the principal activities of the expedition of the Warner and Swasey Observatory of the Case School of Applied Science under direction of Dr. J. J. Nassau.

The corona will be photographed with a wide angle lens and fourteen-foot camera, and motion pictures will be made.

Members of the party will include: S. McCuskey, Prof. E. M. Justin, Dr. John E. Merrill, Sheldon K. Towson, Frank Herzegh, and David Dietz.

THE ULTRAVIOLET radiation from the corona will be photographed through a special quartz lens silvered to exclude all visible light as a part of the observing program of the Perkins Observatory party from Ohio Wesleyan University, Delaware, Ohio, which will be located at Douglas Hill, Me., within the path of totality. These photographs will be made by Prof. M. F. Jordan.

The expedition under Dr. Harlan T. Stetson, director, will also engage in other photometric, spectroscopic and direct photographic observations of the sun's corona, using lenses of long and short focal length, photronic cells, an objective prism and an illuminometer.

The party will include Prof. N. T. Bobrovnikoff, Marvin Cobb, W. A. Spurr, Dr. E. F. Carpenter and Josef Johnson and will work cooperatively with the party from Warner and Swasey Observatory, Cleveland.

DERBY

THE ECLIPSE observations of the expedition from Sproul Observatory, Swarthmore College, Swarthmore, Pa., will be made from Derby, Vt., using a photographic telescope of 63-foot focal length, several smaller lenses, an interferometer and a spectroscope. The large camera will photograph the corona on a large scale.

Dr. John A. Miller, director, who has observed many other eclipses, will head the party, and other members will include Prof. R. W. Marriott, Prof. J. H. Pitman, Prof. M. Kovalenko, Prof. W. R. Wright and G. Bourdelais.

Motion pictures of the eclipse will be made by W. B. Stearns.

Time Table

ASTRONOMERS will utilize times of eclipse determined to fractions of a second, but the following approximate times (p. m., E.S.T.) will act as a schedule for general observations:

	Begin	*Total*	*End*
MONTREAL	2:14	3:24	4:29
CONWAY, N. H. FRYEBURG, ME.	2:19	3:29	4:33
PORTLAND, ME.	2:21	3:30	4:34
GLOUCESTER, MASS.	2:23	3:32	4:36

Duration of totality on the central line of eclipse middle of shaded area on map on opposite page in the Conway-Fryeburg region will be about 99 seconds, diminishing with distance from central line until at the edge of the path it is about 22 seconds. Duration is a little longer to the west along the central line and a little less to the east.

MAGOG

TO OBSERVE his ninth total solar eclipse, Dr. S. A. Mitchell, director of the Leander McCormick Observatory of the University of Virginia, will lead an expedition to Magog, Province of Quebec, Canada.

The same two powerful concave gratings which were used by Prof. Mitchell to observe the eclipse of 1930 from "Tin-Can Island" will be used to continue his study of the heights of the vapors in the solar atmosphere.

Prof. A. C. G. Mitchell of New York University, Dr. Harry A. Barton of the American Institute of Physics, Prof. Arthur D. Butterfield of the University of Vermont, Hamilton McCormick-Goodhart of Washington and Kempton Adams of New York, will join the party. Dr. Mitchell is the author of *Eclipses of the Sun.*

A LARGE PARTY of British astronomers will join Dr. F. J. M. Stratton, director of the solar physics observatory of the University of Cambridge, in observing the eclipse from Magog, Province of Quebec, Canada.

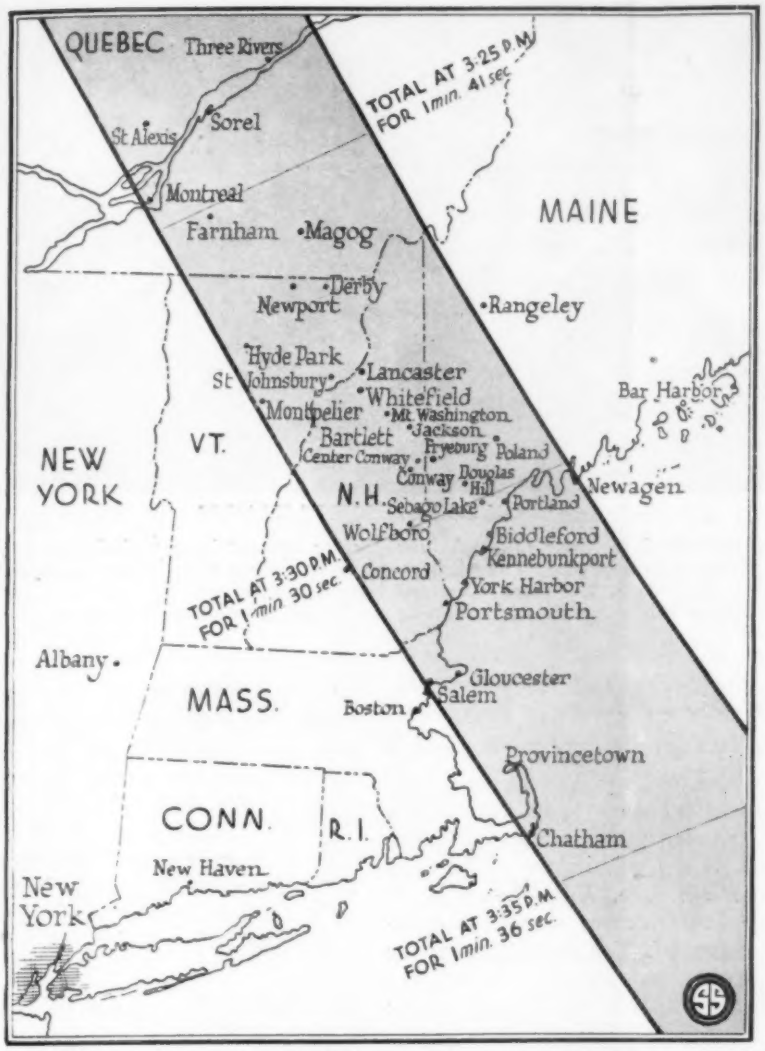
The special observations of the Cambridge University party will include a study of the wavelength of the principal coronal line by an objective interferometer, a photometric study of the intensity of the lines of the sun's chromosphere at different levels in the sun's outer atmosphere and a study of the polarization of the corona in different wavelengths. An array of instruments will be used, including a 19-foot coronograph, an objective grating, spectrographs including a quartz slit one, a 20-inch reflector with a prism spectrograph.

Members of the party will include: Prof. T. A. Carroll, Dr. R. G. Redman, Dr. C. P. Butler, Prof. G. H. Henderson, Dr. F. W. Aston, Dr. C. S. Beals, Dr. H. Knox-Shaw, Dr. T. L. Houghton, Dr. W. J. S. Lockyer, Dr. H. W. Steavenson, T. F. Cameron, Dr. W. Hall, W. S. Thackeray, Col. T. Wiley Cohen.

CONWAY

TWO LARGE CAMERAS, of 85- and 40-foot focal lengths, will be trained on the eclipsed sun by the Franklin Institute party which will be located at Conway, N. H. The large instruments will be fed by coelostats and will be used to record the sun's corona and the partial phases of the eclipse.

Smaller cameras will also be used



ASTRONOMERS AND VACATIONISTS TO SEE TOTAL SOLAR ECLIPSE

Location of the principal astronomical expeditions is shown on this detailed map of the total eclipse of the sun, Aug. 31, in New England and Eastern Canada. Millions of vacationists will join the astronomers in viewing the spectacle.

and motion pictures will be taken. Photographs of the shadow bands, accurate timing of the eclipse, and measurement of light intensity are also on the program.

The party will be under James Stokley, in charge of astronomy for the Franklin Institute Museum and also astronomical staff writer for Science Service. Other members of the party include: David Auspitz, Prof. W. H. Barton of the Pennsylvania Military College, Charles Bittinger, Washington artist who will paint the eclipse, Howard Carl, Dr. L. J. Comrie, superintendent of the British Nautical Almanac, Dr. C. H. Gingrich, I. M. Levitt, Leonard Ormerod, Prof. George H. Peters, retired astronomer of the U. S. Naval Observatory, Dr. George Rosengarten, H. B. Rumrill, and Prof. A. C. Schock.

LIMERICK

LARGE SCALE photographs that will reveal the complicated structure of the sun's corona are the principal objectives of the U. S. Naval Academy expedition.

The observations will be made from Limerick, Me. A 65-foot camera with six and a half inch lens will be used for the corona photographs.

A camera 15 feet long, one 38 inches long with six-inch aperture, a special motion picture camera, two five-inch telescopes and other apparatus will be in operation during the eclipse.

The Navy astronomers under command of Capt. C. H. J. Keppler, U. S. N., will give special attention to photographic and visual observations of the time of the eclipse. The astronomers in the party will include: C. B. Watts, P. Sollenberger, G. M. Raynsford, G. C. Whittaker.

LANCASTER

MT. WILSON Observatory astronomers will observe the eclipse from Lancaster, N. H. The polarization and radiation of the corona, the coronal spectrum, the spectra of any prominences present at the time of eclipse, will be observed. The flash spectrum will be recorded with a moving film spectrograph and the eclipsed sun will be photographed directly through a silvered quartz lens. Three grating spectrographs, a special short focus radiation telescope and three coelostats will be included among the apparatus used.

Dr. Seth B. Nicholson will be in immediate charge of the observations and Dr. W. S. Adams, director of the observatory will be a member of the party. Other astronomers in the party will be H. D. Babcock, F. Ellerman and Dr. Edison Pettit.

FRYEBURG

THE ECLIPSE expedition of Lick Observatory at Mt. Hamilton, Calif., will be located at Fryeburg, Me. Photographs of the corona, its spectrum and the flash spectrum, will be made.

Dr. W. W. Campbell, a veteran eclipse observer, director emeritus of the observatory and president emeritus of the University of California, will be a member of the party which will be under the direction of Dr. J. H. Moore. Other members will include: Dr. W. H. Wright, Dr. C. D. Shane, Dr. D. H. Menzel, and J. F. Chappell.

Two photographic telescopes of 15-foot focal length and one of five-foot focal length and nine spectrographs of various sorts will be used.

THE EINSTEIN shift of star light during the eclipse will be tested by direct photography by the Georgetown College Observatory party from Washington, D. C., under charge of Dr. Paul A. McNally, S. J., that will be located at Fryeburg, Me.

The infrared or heat spectrum of the corona will be observed with a direct-vision spectrograph with camera attached, and the light variation during totality will be measured with photoelectric cells and electrometers.

Special attention will be given to an anomalous increase in light intensity at about the middle of totality, that was

last observed by Father Wulf of Valkenburg, Holland, in 1914.

Rev. E. J. Kolkmeyer, S. J., of Georgetown, Rev. T. D. Barry, S. J., and Rev. J. P. Delaney, S. J., of Canisius College, Buffalo, will join the Georgetown party.

DR. W. H. PICKERING of the Mandeville Observatory, Jamaica, will observe the approach and recession of the moon's shadow at Fryeburg, Me., during the eclipse. Motion pictures will be taken.

CAPTIVE balloons and airplanes will be used by Dearborn Observatory, Evanston, Ill., astronomers to observe changes in the temperature and pressure of the air at various altitudes during the time that the moon's shadow falls on the earth, Aug. 31. The eclipse observations will be made from Fryeburg, Me.

A battery of motion picture cameras especially equipped for the purpose will make a record of the whole eclipse. Dr. Oliver Justin Lee, director, will have the cooperation of Capt. Barnett Harris, Signal Corps, U. S. A., who will have charge of the movie operations. Other members of the party will be Prof. Ernest G. Bryant, Middlebury College, Vt., and Newton L. Pierce.

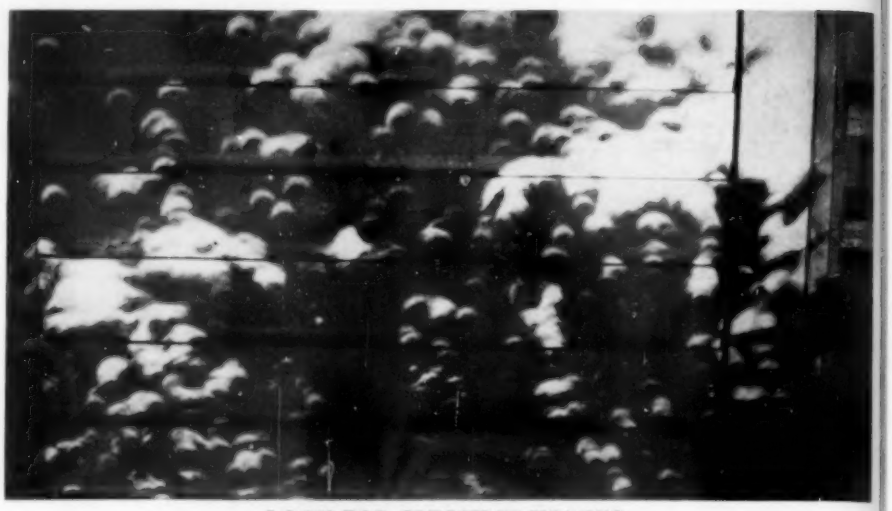
PROF. E. A. FATH, director of the Goodsell Observatory, Carleton College, Northfield, Minn., will observe from Fryeburg, Me.

DR. HEBER D. CURTIS, a veteran eclipse observer, will lead the University of Michigan party to observe from Fryeburg, Me.

Accompanying the party of professional astronomers there will be three Detroit amateur astronomers, Robert R. McMath, Francis C. McMath and Judge Henry S. Hulbert, who will make motion pictures of the eclipse using a special camera and camera drive built for the eclipse.

The McMaths and Judge Hulbert have made a hobby of astronomical motion picture photography, developing methods and apparatus at a special observatory at Lake Angelus, Mich., which they last year presented to the University of Michigan.

Dr. Curtis will photograph the corona with a lens of 40-foot focal length, and he will also observe the flash spectrum in the visual and infrared regions. Interferometer measurements of the corona will also be made. Dr. D. B. McLaughlin and Baldwin Curtis will be members of the party.



LOOK FOR CRESCENT IMAGES

When the sun is partially eclipsed, look for the crescent images of the sun as formed through the foliage of trees. The photograph shows how the crescents will appear as on the side of a house. The same effect can be obtained by piercing a piece of cardboard with a sharp pin or needle and obtaining an image of the sun through the tiny hole.

SEBAGO LAKE

HARVARD COLLEGE Observatory astronomers will observe the eclipse from Sebago Lake, Me., and their efforts will be concentrated upon the color, brightness and polarization of the sun's corona. Dr. F. L. Whipple will be in charge, L. B. Andrews with the cooperation of Dr. W. M. Cohn will study the polarization, and W. A. Calder will use a photoelectric cell. Small photographic and telescopic equipment will be used.

CENTER CONWAY

USING MIRRORS coated with chromium by a process just perfected by Dr. Robley Williams, the eclipse observing party from Fuertes Observatory of Cornell University, Ithaca, N. Y., will attempt to photograph the ultraviolet spectrum of the corona from Center Conway, N. H.

Profs. S. L. Boothroyd, director, R. W. Shaw and Robley Williams and other observers will also use mirrors to photograph the visible spectrum in the same way.

THE STRUCTURE and light intensity of the sun's corona will be studied by an expedition of the Van Vleck Observatory of Wesleyan University at Middletown, Conn., which will observe the total eclipse from Center Conway, N. H., Dr. Frederick Slocum, director, will lead the expedition. Using a lens of 25-foot focal length, two lenses of 11-foot focal length, two eight-inch mirrors and several smaller photographic lenses, the corona will be photographed in light of various colors.

Profs. C. L. Stearns, B. W. Sitterly, Lois T. Slocum and N. W. Storer will be in the party. Dr. Slocum is chairman of the eclipse committee of the American Astronomical Society.

BIDDEFORD and SACO

THE SUN'S eclipse will conveniently visit the two private observatories of F. C. Deering, lumber manufacturer and amateur astronomer. At his winter home at Saco, a ten and a half-inch telescope will be in operation and at his summer home at the sea a six-inch telescope will be used.

MT. WASHINGTON

FROM the highest point in the path of eclipse, the summit of Mt. Washington, N. H., a Science Service party will make direct photographs of the sun, photograph the approaching and retreating shadow of the moon and take motion pictures of the eclipse.

The elaborate expeditions from the large observatories have selected observing sites at lower elevations where prospects for clear weather are more hopeful than they are on the top of Mt. Washington, 6288 feet above sea level. The Science Service expedition has been planned in order that (*Turn to page 75*)

Partial Phases Also of Interest To the Astronomer

Corona Not Visible, But Shadow Bands Appear And Other Phenomena May Be Observed

ALTHOUGH the total eclipse of the sun will be of greatest interest, the partial phases should also be observed. The total eclipse will be seen for a hundred seconds or less, about 3:30 p. m., Eastern Standard Time, along a path a hundred miles wide crossing eastern Canada and New England. But the partial eclipse will be seen over this same area for about an hour before and afterwards, and also over the entire United States and Canada.

The path of totality is formed by the passage of the moon's shadow, about a hundred miles long, and sixty miles wide, across the surface of the earth. This part of the shadow is called the umbra, it is the region in which the sun is completely obscured by the moon. Because the sun is so much larger than the moon, 864,000 miles in diameter as compared with 2,160, the umbra forms a cone, its base at the moon, its apex about 232,000 miles away, on the side away from the sun. Even at best, when the earth is closest to the moon, the tip of the shadow does not reach more than 18,250 miles beyond the earth's surface. Then the shadow on the ground is about 167 miles in diameter. On August 31, the tip of the umbra will be much nearer the earth's surface, and the shadow spot will be about sixty miles in diameter. But because the sun is low in the sky, about 30 degrees above the horizon, this is spread out into an ellipse, about a hundred miles long. The direction of its motion is practically parallel to the short direction.

Half Shadow

Around the umbra, there is a "half shadow," the penumbra. This is the region in which the moon covers only part of the sun's disc. It is also conical in shape, but is a cone which becomes larger as the distance from the moon increases. Consequently, it covers, on August 31, the whole of North America, and parts of Asia and South America. Over this entire area a partial eclipse will be viewed, a greater amount of the sun being covered by the moon the nearer the point is to the path of totality.

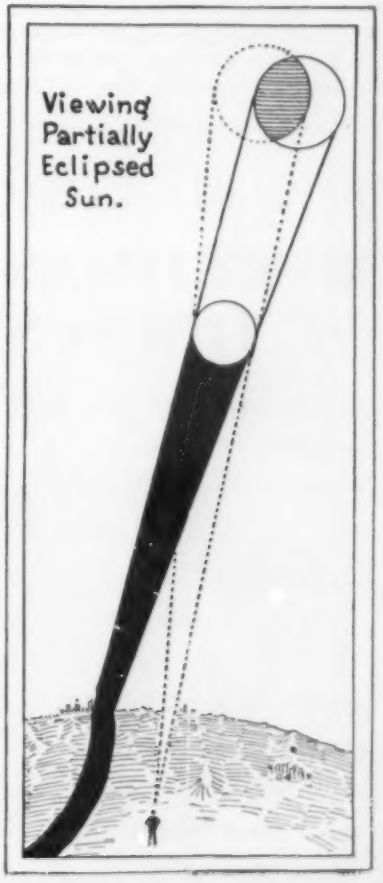
As far away as San Francisco and Los Angeles, California, 15 per cent. of of the sun's diameter will be covered when the eclipse is at its height. Galveston, Texas; Denver, Colorado; Helena, Montana; and Juneau, Alaska, will get about 50 per cent. obscuration. New Orleans, Louisiana; Abilene, Kansas; Medicine Hat and Edmonton, Alberta; will have about 60 per cent. Atlanta, Georgia will have about 73 per cent; Nashville Tenn., the same; Minneapolis, Minn., 78 per cent.; Winnipeg, Manitoba, 78 per cent.; Chicago, 79 per cent.; Detroit, 85 per cent.; Cleveland, 87 per cent.; Pittsburgh, 88 per cent.; Washington, 89 per cent.; Buffalo, 91 per cent.; Toronto, 92 per cent.; Philadelphia, 93 per cent.; New York, 95 per cent.; New Haven, 96 per cent.; Albany, 97 per cent. and Boston, 99 per cent.

Hour and Half in California

In these places, around noon, or in the early afternoon, a small nick will appear in the edge of the sun, if it is viewed with proper protection for the eyes. This nick will increase, and the moon's circle will be seen passing above the upper edge of the sun, from right to left. As the maximum is reached, the crescent of sunlight, which remains, will slip around underneath the moon, and will then start to get larger as the moon moves away. Even in southern California the partial eclipse will last about an hour and a half, and nearer the path of totality it will be still longer.

Where the partial eclipse has a magnitude as much as 15 per cent. many effects can be noticed. The circular spots of light which appear under trees, images of the sun formed by the pinhole-like interstices between the leaves, become crescent shaped, reproducing the appearance of the sun. Where the eclipse is about 60 per cent. or more, the sun's light is noticeably reduced and it takes on a peculiar color, because the light then comes mostly from the outer part of the solar disc, which is quite different from that of the inner part, with which it is ordinarily mixed. Where the eclipse reaches 90 per cent. or more, the shadow bands may appear. These are fleeting strips of light and shade, which flit across the ground. Really they are shadows of layers in the atmosphere of different temperature, made visible when the light comes from the slit-like crescent of the sun. A similar effect causes twinkling of the stars. When the eclipse is as much as 95 per cent., the animals may notice it, chickens may go to roost, and flowers may close. However, even where totality reaches 99 per cent., the corona does not come into view, for the remaining crescent, small as it is, gives sufficient light to hide it. After the maximum eclipse is passed, the crescent enlarges, and the phenomena previously observed are seen again, in reverse order. All these things, of course, are also seen from the total eclipse area, before and after totality.

Science News Letter, July 30, 1932



CAUSE OF PARTIAL ECLIPSE

This diagram shows why the sun will appear only partially eclipsed to those outside the narrow band of totality.

Amateur's Aid Desired In Study of Eclipse Features

Weather Conditions, Temperature Changes and Data On Exact Edge of Path Should Be Recorded If Possible

TO THE AMATEUR astronomer who wants to aid his professional brethren will come an opportunity to be of service with the total eclipse of the sun. While many of the world's greatest astronomers will be located in the eclipse track, equipped with instruments large and small, there are many ways in which the amateur can assist, either with very simple apparatus, or with no equipment at all. But whether or not one makes any such experiments, the eclipse is interesting enough in itself. It is a majestic spectacle that, once seen, can never be forgotten. And even snapshots, made with a small camera, will provide one with a permanent record of the event.

One particularly interesting way to make a photograph is to include all the partial phases in the same picture as the total eclipse. To do this, the camera, which can be an ordinary kodak, should be set on some firm support, preferably a regular camera tripod. Begin the series at about 2:20, Eastern Standard Time, as the partial eclipse begins. Set the camera so that, as you look down in the finder, the sun is in the upper right hand corner. In other words, the sun will photograph in the upper left hand corner of the finished picture, since the finder reverses right for left. Thus, as the sun moves to the right and downwards, it will stay in the range of the lens.

Of course, a picture taken right into the sun would be vastly overexposed, if the usual exposures were given. Stop the lens down to its smallest diaphragm opening, and give the shortest exposure the shutter provides. Then you will probably get a fairly well exposed image. If you have time, it might be well to devote a couple of films to a trial of different speeds some days before the eclipse, by taking actual pictures of the sun, and then having them developed to see what you get. A color filter will help reduce the light if the exposure is still too long. Better still is a neutral filter which one of the photographic companies (Eastman Kodak Co.) is providing for the purpose. When this is over the lens, a correctly exposed image of the sun is obtained in 1/25 of a second with the stop F. 16.

Start at 2.15 P. M.

With the camera set and the shutter and lens adjusted, take a shot of the sun at 2:15 p. m., Eastern Standard Time, just before the eclipse starts. Then, without moving the camera, take another five minutes later, and so on, at regular intervals, as the dark disc of the moon covers the sun. The sun moves its own diameter in two minutes, so each image will be clear of its predecessor. If you find that it is moving out of the finder, reset the camera, being sure to change the film. As totality approaches, about 3:30, open the diaphragm all the way, and try to catch the Baily's beads, the spots of light which appear around the moon at the beginning of totality. During totality, remove the filter, and photograph the corona, with an exposure of several seconds. If you wish, you might try several exposures, with times varying from a half second to five or ten seconds, changing the film between each. When totality is over, try to catch the Baily's beads when they reappear, and continue the five-minute exposure as the moon uncovers the sun.

Such a picture will probably be of more value as a personal memento than a scientific record, for the images of the sun will be very small.

Ways in which the amateur can assist the professional include observations of the exact edge of the moon's shadow. If you are near the edge of the eclipse path, astronomers would like to know the answer to these questions:

Questions for Amateurs

Was the bright disc of the sun hidden at any time? If so, for how many seconds?

Did you see the corona, consisting of white streamers around the moon?

If it was dark where you were, did you notice any place in the distance where it still seemed to be sunlit, to the west, if you were on the western edge of the path, or to the east, if you were near the eastern side?

If you reported any of these things, what was your exact location at the time?

You can also make observations of the shadow bands, the bands of light and shade that sometimes appear before and after an eclipse. If you see them, you should report how they were moving, their direction, the distance between them, and how long you saw them. A large white area, such as a bed sheet, is the best surface on which to see them. You might even try to photograph them, though so far this has not been accomplished. A record of them with a motion picture camera would be especially valuable.

Another simple observation is of the temperature changes. With a good thermometer, placed in the shade, take temperature readings at regular intervals as the eclipse advances, perhaps every five minutes, except the period which includes totality, and then every minute, noticing especially the lowest temperature achieved. And if you get any of these records, don't keep them to yourself. Send them to Science Service, 2101 Constitution Ave., Washington, D. C., and the most effective use possible will be made of them.

S. A. Mitchell's

● ECLIPSES OF THE SUN

will be published in a third, completely revised edition especially ready for the August 31st eclipse ● Profusely illustrated ● Price, $5.00 ● Astronomers all know of it. "It's the only modern work on the subject for the layman"—The New Republic ● Available in Braille ● Order now from Columbia University Press, 2960 Broadway, New York, N .Y. ●

Single Cloud May Ruin Plans Carefully Laid By Astronomers

Hopes Are Pinned on Having Favorable Weather Conditions For History Shows Generally Clear Skies on Eclipse Date

THOUGH the astronomer can predict a total eclipse of the sun, like that to be seen in eastern Canada and New England on Wednesday afternoon, August 31, years in advance, the science of meteorology has not yet reached the same degree of accuracy. Not until a few hours before the eclipse happens will it be possible to tell with certainty whether the weather will be clear, or whether clouds will render the elaborate preparations of no avail. Rain is not necessary to spoil an eclipse expedition. A single cloud, properly placed before the sun in an otherwise clear sky, will do just as much to ruin eclipse observations as a heavy storm.

Weather Records Studied

The best that can be done is to choose a place from which to see the eclipse where the weather records of some years back show the most generally clear weather on the day and hour of the eclipse. Sometimes there is not much choice. In October, 1930, there was an eclipse in the South Pacific Ocean, and a small tropical island was the only accessible land along its whole course. But this year the path extends through a long stretch of populated country. Studies have been made and they show that in past years it has been clear at the eclipse date for about 60 per cent of the time from the St. Lawrence River south to the Atlantic Coast, so that it all seems pretty good. A few spots are not quite so favorable. On the mountain peaks, like Mt. Washington, there is more danger of clouds, and there may be fog along the coast.

Weather probabilities, however, cannot always be trusted. In September, 1923, there was an eclipse visible in California, and the chances for clear weather seemed almost perfect. But alas, the famous California climate failed to materialize, and none of the astronomical parties there were successful, though in a few spots the eclipse was seen through light clouds, and farther south, in Mexico, good results were obtained. Next was an eclipse in January, 1925, visible in the early morning along the New England coast. The chances seemed almost hopeless, but elaborate preparations were made, in the hope that it might be clear after all. These hopes were fully justified, and practically all the observing parties were successful. So the astronomers this summer will make their preparations and hope for the best. If clouds prevail, they will know that they have done all that is humanly possible. The greatest danger is from local thunder showers, but with the expeditions so widely scattered, it is almost certain that somebody will get something.

This may break a tie that now exists between three of the leading eclipse specialists of the United States, each of whom has observed seven in the past. They are Dr. W. W. Campbell, director emeritus of the Lick Observatory; Dr. John A. Miller, of the Sproul Observatory of Swarthmore College, and Dr. S. A. Mitchell, of the McCormick Observatory of the University of Virginia. Only Dr. Miller, however, has a perfect "batting average," as he has had clear weather at every eclipse he has attended, the first being in 1900. Dr. Mitchell has been to eight, but had clouds once, while Dr. Campbell has attempted nine, but has been foiled twice. Even more unlucky is the record of Dr. Heber D. Curtis, of the University of Michigan observatory, who has attended ten, but has observed only six.

Worst Luck

Probably the worst luck has followed Dr. David P. Todd, director emeritus of the Amherst College Observatory. He began his studies of eclipses more than half a century ago, with the eclipse seen in the western United States in 1878, and has made eleven attempts. But only four have been successful, as it was cloudy at seven of them. Another astronomer with a record almost as good as Dr. Miller's is Prof. George H. Peters, of the U. S. Naval Observatory, who had clear weather on all six of his expeditions.

All these astronomers will probably be in the path of totality on August 31. Perhaps, after that, the record may be different.

Science News Letter, July 30, 1932

THIS IS THE WAY THE ECLIPSE WILL APPEAR TO MANY

Most of the great centers of population in the East will get this view of the August 31 eclipse, which will be total in a narrow path across New England and Canada. The phases of a large partial eclipse, about 90 per cent. or more of total, are shown above. In most of the United States the crescent will narrow as the moon covers the solar disc, then, at the maximum, it will slip around underneath and enlarge as it appears on the other side. North of the path of totality, in northern Maine and eastern Quebec, the crescent will slip around above the sun.

Flames From Sun Seen Without Eclipse

"A Classic of Science"

Bright Lines of Prominence Spectrum May Be Followed With Spectroscope Where They Occur Around Sun's Disk

These two reports were presented at the same session of the French Academy and published in the same number of COMPTES RENDUS hebdomadaires des Seances des l'Academie des Sciences Tome 67. Paris: Juillet-Decembre 1868. (*Translated for the* SCIENCE NEWS LETTER *by Helen M. Davis.*)

THE PERMANENT Secretary communicated the following telegraphic dispatch from Mr. Janssen, sent to observe the total eclipse of the sun: "Eclipse observed, Protuberances, spectrum very remarkable and unexpected, protuberances of a gaseous nature."

Indication of some of the results obtained at Guntoor during the eclipse of last August, and following that eclipse. Letter from Mr. Janssen to the Permanent Secretary.

Cocanda, September 19, 1868

"I have just come from Guntoor, my station for observing the eclipse, and I am taking advantage of the departure of a courier to send the Academy news of the mission with which it honored me.

Time does not permit me to send a detailed account; I shall have the honor of sending that by the next courier. Today I shall merely sum up the principal results obtained.

The station at Guntoor was without doubt the most favored: the sky was clear, especially during totality, and my powerful telescopes of nearly 3 meters focal length allowed me to make an the eclipse.

Immediately after totality, two magnificent protuberances appeared; one of which, more than 3 minutes in height, shone with a splendor which it is difficult to imagine. Analysis of its light immediately showed me that it was formed by an immense column of incandescent gas, composed principally of hydrogen.

Analysis of the circumsolar regions, where Mr. Kirchhoff places the sun's atmosphere, did not give results conforming to the theory formulated by that illustrious physicist; it seems to me that these results ought to lead to knowledge of the true constitution of the solar spectrum.

But the most important result of these observations is the discovery of a method, the principle of which was conceived during the eclipse itself, which allows study of the protuberances and of circumsolar regions at any time, without the necessity of recourse to the interposition of an opaque body in front of the sun's disk. This method is based on the spectral properties of the light of protuberances, light which is resolved into a small number of very bright lines, corresponding to dark lines in the solar spectrum.

On the day following the eclipse the method was applied with success, and I was able to watch phenomena presented by a new eclipse which lasted all day. The protuberances of the former one were profoundly modified. There remained scarcely any traces of the great protuberance and the distribution of gaseous material was entirely different.

From that day to the 4th of September, I studied the sun constantly from this point of view. I made maps of protuberances which show these immense gaseous masses changing and moving about with great rapidity (often in a few minutes). Finally, during this period, which was like an eclipse seventeen days long, I learned a great number of facts, which appeared spontaneously, about the physical constitution of the sun.

I am happy to offer these results to the Academy and to the Bureau of Longitude in response to the confidence which was shown in me and the honor which was done me in entrusting me with this important mission."

Lockyer's Discovery

On a method employed by Mr. Lockyer to observe at any time the spectrum of protuberances shown in total eclipses of the sun. Note by Mr. Warren de la Rue.

"I have the pleasure of forwarding to Mr. Delaunay two letters relating to a discovery of one of my friends on the subject of the rosy protuberances which are seen during total eclipses of the sun. Mr. G. Norman Lockyer, using an especially constructed spectroscope, has been able to observe the brilliant lines of a protuberance superimposed upon the ordinary spectrum, when, in traversing the edge of the sun, the instrument happens upon such an object. This discovery was made the 20th of this month."

First Letter—

Mr. Balfour Stewart to Mr. W. de la Rue.

October 21, 1868.

"Lockyer has had a triumph; he has found the red flames with his new spectroscope. He says, October 20:

I found a protuberance today with the new spectroscope and got the positions of three lines:

One=C exactly,

One=F pretty nearly,

One, 8 or 9 degrees on Kirchhoff's scale, more refrangible than the line D!"[1]

(*Turn to page* 76)

MEDALLION

—of Janssen and Lockyer struck by the French Government in appreciation of their simultaneous discovery.

[1]This line proved to belong to the element Helium, named by Lockyer for the sun, discovered on earth by Ramsay in 1894.—H. M. D.

Radio Experimenters Will Observe Eclipse With Interest

In Path of Totality Moon Will Block Flow of Atoms From Sun, Affecting Strength of Radio Signals

RADIO as well as astronomy will benefit from observations of the total eclipse of August 31. Scores of astronomers will be within the narrow path of the moon's optical shadow that cuts across Canada and New England on the eclipse afternoon, and they will have a little more than a minute and a half for observations. Radio experimenters will observe a newly recognized sort of eclipse, a "corpuscular eclipse," caused by the moon interfering with a flow of atoms driven forth from the sun by the pressure of light. Instead of using telescopes, cameras or eyes, such as will be used to record the visible eclipse, the radio observers will measure for several hours the signal strength of radio transmissions.

Since the rise of radio the existence of layers of air in the earth's upper atmosphere that reflect radio waves and allow them to travel long distances has been recognized. Called Kennelly-Heaviside after the American and the Englishman who discovered it, the ionized or conducting layer was first recognized to exist about 60 miles up. It is born of radiation from the sun, as is proved by the changes that it undergoes with the cutting off of the sun's light at night and the coming of light in the morning. Until recently, the Kennelly-Heaviside layer was not suspected of being twins, but research in England and in this country has proved that there are really two layers, the original layer at an altitude of 60 miles and another layer at 120 miles.

There are two theories about the origin of the layers and the coming eclipse may render a decision between them. One is that ultraviolet light from the sun is responsible for both layers. The other view is that the lower layer, as Prof. S. Chapman of the Imperial College of Science and Technology, London, holds, may be caused by neutral particles streaming from the sun. Prof. E. V. Appleton of King's College, London, suggested that these two theories may be tested at the August 31 eclipse and they are enlisting the aid of observers in all parts of America and Europe.

If the streaming of neutral atoms or corpuscles from the sun at the rate of a thousand miles per second causes interference with radio transmission by affecting the ionized layers, this "corpuscular eclipse" will be observed east of the path of optical total eclipse and the shadow of the moon in the rain of corpuscles will not even fall upon some of the hundred-mile-wide path that will be darkened by the optical eclipse. The center of the radio or corpuscular eclipse will pass through Spitzbergen, Greenland and mid-Atlantic and it will cut a swath of about 1,600 miles compared with the hundred miles for the visible total eclipse. The radio eclipse will happen some two hours earlier than the visible eclipse because the corpuscles travel slower than light.

England is within the area of corpuscular eclipse and Profs. Appleton and Chapman are recruiting observers both there and in the United States. Radio amateurs who have a simple detector milliameter as a part of their short wave sets can participate. In Canada, the Canadian National Research Council, McGill University and commercial communication companies are cooperating in sending expeditions to observe the "radio eclipse" from Canada and Newfoundland.

After the eclipse, thanks to the discovery of the radio eclipse, we may be more positive as to what happens to radio waves only a few miles above our heads every day and night.

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Points of View, Continued from Page 70

the eclipse may be recorded in the remote contingency of cloudy weather at lower altitude combined with clear weather on Mt. Washington.

A special camera of 30-inch focal length will be used for the direct photographs. The party will include Watson Davis, managing editor of Science Service, Paul Brockett, assistant secretary of the National Academy of Sciences, and William Brockett.

YORK HARBOR

HOWARD RUSSELL BUTLER, artist who has traveled to Oregon, California and Connecticut to paint past total eclipses of the sun, will have the Aug. 31 eclipse sit for him at his studio at York Harbor, Me. He will have 93 seconds in which to paint its portrait.

MONTREAL and PARENT

THE ROYAL OBSERVATORY at Greenwich, England, will send an expedition to Parent, P. Q., Canada. Imperial College, London, will also be represented by an expedition that will observe from Montreal.

PROF. D. W. MOREHOUSE of Drake University, Des Moines, will observe from Montreal where he will cooperate with a British expedition.

WHITEFIELD

THE Seagrave Observatory, Providence, R. I., expedition will observe from Whitefield, N. H.

BARTLETT

ASTRONOMERS from the Tokio Imperial Observatory will observe from Bartlett, N. H.

JAPANESE-RUSSIAN

A PARTY from the National Observatory, Poulkovo, Russia, under direction of Prof. A. Belopolsky and a party from the Kwasan Observatory of the Kyoto Imperial University, under direction of Prof. Issei Yamamoto, will observe the eclipse, the American Astronomical Society has been informed, but the exact locations of their observing stations is not now known.

AMATEURS

OBSERVATION of the eclipse by amateurs is being organized by the Amateur Astronomers Association. Observers who desire to affiliate themselves with this group are invited to communicate with Dr. Clyde Fisher at American Museum of Natural History, New York.

BROADCASTING

RADIO broadcasts will carry descriptions of the eclipse to those outside the path of totality who will be able to see only the partial phases.

The Columbia Broadcasting System will broadcast from Conway, N. H. James Stokley, astronomical writer for Science Service, in charge of the Franklin Institute eclipse party, and an announcer will describe the eclipse.

The National Broadcasting Company will broadcast from Norway, Me.

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7 GREAT SCIENTISTS

1 DR. ROBERT A. MILLIKAN, Nobel prize winner in physics, leader in scientific thought and head of the California Institute of Technology, speaks on *"The Rise of Physics."*

2 DR. JOHN C. MERRIAM, authority on the fossil animals and reptiles of western America, president of the Carnegie Institution of Washington, speaks on *"The Record of the Rocks."*

3 DR. EDWIN G. CONKLIN, Princeton University biologist, one of the world's greatest authorities on life processes, speaks on *"The Mystery of Life."*

4 DR. KARL T. COMPTON, eminent physicist, president of the Massachusetts Institute of Technology, speaks on *"Science and Engineering."*

5 DR. LEO H. BAEKELAND, industrial chemist and one of America's industrial pioneers, inventor of bakelite, velox, etc., speaks on *"Chemistry and Civilization."*

6 DR. WILLIAM H. WELCH, of Johns Hopkins University, "Dean of American Medicine" speaks on *"The Tubercle Bacillus."*

7 DR. WILLIAM M. MANN, director of the National Zoological Park of the Smithsonian Institution, leading authority on animal life, speaks on *"Our Animal Friends."*

THEY WANT TO TALK TO YOU IN YOUR OWN HOME

SCIENCE is absorbingly interesting. Scientists bring forth new points of view, new discoveries, new relationships of old discoveries, and thus they themselves are absorbingly interesting as human beings.

Men and women of intellectual curiosity would like to entertain many of these scientists, one by one, in their homes, but this is usually impracticable.

A SO Science Service, Inc., asked seven great scientists to make phonograph records on subjects which fired them with enthusiasm.

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D On the reverse side of each picture we printed a brief biography of the scientist, together with his complete speech as recorded on the record.

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Continued from page 74

Second Letter—

Mr. G. N. Lockyer to Mr. W. de la Rue.

London, October 23, 1868.

"Many thanks for your kind letter and your congratulations; they are a sufficient recompense for much work and patience. I say this because, for two and a half years, I have worked almost against all hope.

I should have been content for the moment to have sent a note to Dr. Sharpey (Secretary of the Royal Society), and to have announced my observation to Mr. Stewart, who, by chance, spent the day following the one on which I made the discovery with me; for I wished to finish the work, or at least make some progress on it before talking about it.

Nevertheless I can only thank you for what you have done: the communication which you sent in to the Academy will be very valuable to me.

I was fortunate enough to find the protuberance again yesterday (October 22), and I confirmed everything: lines (bright) at C, almost at D and very close to F. There were certainly no lines at B nor at *b*. As for the region G, I have not examined it again.

I read the Note from Mr. Rayet, the night before my observation of the protuberance. I thought at first that I had observed only three lines, out of nine on which the observation is possible. But in studying again Mr. Rayet's diagram in Comptes Rendus I think that that diagram clears up the matter to a certain extent. You will note that *he gives a greater length to three lines;* I think that all the other lines which he has seen come from that very brilliant part of the ordinary solar spectrum which is seen when the region just beyond the edge of the sun is observed. It seems to me that this explanation is the more probable since Mr. Rayet observed with a very wide slit. Moreover, there is in the solar spectrum an extremely bright region, between the two more refrangible lines of *b*, exactly in the position where Mr. Rayet places a short line; there is also a very bright part between *b* and F where he puts another line.

To sum up:

1. I have determined three lines;
2. Rayet gives three lines longer than the others;
3. Tennant is sure of three lines;
4. Herschel is sure of three lines.

It seems to me that the letters of Herschel and Tennant and also Rayet's diagram show that their nomenclature rests essentially upon a more or less rigorous estimation, and not upon measurements; none of these gentlemen seem to have thought of putting a faintly illuminated scale in the field of his telescope.

Thus my three lines may, after all, represent a greater amount of work accomplished than I at first imagined.

With a narrow slit, the lines have been seen even at a small distance above the surface of the sun itself. There is one especially brilliant line, and Mrs. Lockyer had no difficulty in seeing it.

The lines extended to different heights above the edge of the sun; the red was the shortest. I have even been able to get a clear idea of the shape of the protuberance which must be that shown in the figure:

When the slit has been adjusted so as to fall upon *a*, the bright line is found entirely separate from the solar spectrum.

Here is another fact: although C and F are both believed to be hydrogen lines, nevertheless they are not of equal length: the red one comes nearer to the sun."

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